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Studies on Egg Production Index in Some Newly Evolved Multivoltine Breeds of the Silkworm, *Bombyx mori* L.

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To know the impact of female pupal weight corresponding to the male cocoon shell weight upon fecundity, hatchability and percentage of non-viable eggs, the experimental multivoltine breeds namely BL67 and 96A were categorised into low, medium and high batches according to the weight of female pupae and male cocoon shells and moths emerged from low, medium and high female pupae were allowed to mate withmoths emerged from low, medium and high male cocoon shells. Both the experimental breeds of BL67 and 96A revealed a fairl trend in fecundity for high batch > medium batch > low batch. When data were statistically analysed, a significant ($p < 0.05$) and a highly significant ($p < 0.01$) increase in fecundity was observed in the medium and high batches of BL67 during November – December, 2002 whereas highly significant ($p < 0.01$) increase was observed in the high batches of 96A during November – December, 2002. Data revealed a highly significant ($p < 0.01$) increase in fecundity in medium and high batches of both the breeds during January – February, 2003. More interestingly, a significant ($p < 0.05$) reduction was noted in percentage of non-viable eggs in high batches of 96A during January – February, 2003. But no significant variation in hatchability was noticed due to the effect of differential female pupal weight and male cocoon shell weight.

Key words: *Bombyx mori* L., Fecundity, Multivoltine, Pupal weight

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Introduction

Fecundity in insects is influenced by several factors like mating frequency (Norris, 1936), time (Goodwin and Madsen, 1964), chilling (Parrish and Bickley, 1966) etc. Mating stimulates oviposition in insects and usually mated females lay eggs at a higher rate as compared to unmated ones (Ridley, 1988). In Tasar silkworm, *Antheraea mylitta* D., the number of eggs laid was attributed to the variation in the weight of female pupae (Ahsan and Khanna, 1976). Similarly, Miller *et al.* (1982) opined that the pupal weight was found to be the best estimator of fecundity in case of *Antheraea polyphemous* Cramer. A strong association between silk gland and fecundity and positive significant correlation between fecundity/cocoon weight, fecundity/cocoon shell weight was found in Tasar silkworm, *A. mylitta* (Siddiqui *et al.,* 1989). A positive and significant correlation between female moth weight and fecundity was observed in the Oak tasar silkworm, *A. proylei* J. (Ghosh *et al.,* 1996). Kotikal *et al.* (1989) have found relationship between pupal size and egg production in Eri silkworm, *Samia cynthia ricini.*

In the mulberry silkworm, *Bombyx mori* L., several factors are known to affect fecundity. Correlation studies between the duration of mating and the number of viable eggs laid by the silkworm, *B. mori* was carried out by Narayanan *et al.* (1964), effect of mating duration on the viability of silkworm, *B. mori* eggs (Jadhav and Gajare, 1978), sublethal doses of Thuricides, a pesticide (Krishnaswami *et al.,* 1981). Variation in fecundity has been studied by various means like rearing at reduced temperature (Kremky and Michalska, 1984), Insect Growth Regulators (IGRs) namely methoprene, triprene, diflubenzuron (Gaaboub *et al.,* 1985), agronomical methods, *i.e.*, fertilizers and spacing (Venugopal Pillai *et al.,* 1987), abnormal number of ovarioles (Benchamin *et al.,* 1988), temperature and relative humidity (Puttaswamy Gowda, 1988), the bacterium, *Bacillus thuringiensis* var. Kurstaki (Hassan *et al.,* 1989).

Narayanswamy and Visweswara Gowda (1989) reported that the pupal weight of the parent generation significantly influenced the fecundity in bivoltine silkworm breed, NB18 and a visible decrease in hatching from 81.9 – 73.8% was observed when moths emerged from increasing male pupal weights in the parent generations, Rajanna and Sreerama Reddy, (1990) established significant correlations between 5th instar larval weight and cocoon shell weight, mating capacity of male moths (Benchamin *et al.,* 1990), minerals in rain water (Thangavelu and Bania., 1990) and various concentration of Ascorbic acid (Rahman *et al.,* 1990). Shaheen *et al.* (1992) found a positive and highly significant correlation between pupal weight and fecundity in bivoltine silkworm. Jayaswal *et al.* (1991) and Singh (1994) have demonstrated a positive correlation between female pupal weight and fecundity in the multivoltine breed A25. Ravindra Singh *et al.* (1994a) have observed a positive correlation between female cocoon weight and fecundity in the multivoltine breed Mysore Princess. Effect of hydrogen peroxide and aspirin on economic characters of the mulberry silkworm, *B. mori,* has been studied (Ravindra Singh *et al.,* 1994b). Vineet Kumar *et al.* (1998) reported a positive correlation of pupal size to egg fecundity and silk yields in silkworm. Recently, effect of Diethylstilbestrol synthetic nonsteroidal estrogen on fecundity has been reported in silkworm, *B. mori* L. (Babila Jasmine *et al.,* 2002).

Perusal of literature reveals that no work has been carried out on the impact of female pupal weight corresponding to the male cocoon shell weight upon fecundity, hatchability and percentage of non-viable eggs of *B. mori* L. Therefore, the present study has been planned to know the effect of differential female pupal weight coupled with differential male cocoon shell weight on fecundity, hatchability and percentage of non-viable eggs by utilizing the newly evolved multivoltine silkworm breeds namely BL67 and 96A at the Multivoltine Breeding Laboratory of Central Sericultural Research & Training Institute, Mysore.

Materials and Methods

The present study on the effect of differential female pupal weight and male cocoon shell weight on fecundity, hatchability and percentage of non-viable eggs was carried out at Multivoltine Breeding Laboratory, Central Sericultural Research & Training Institute, Mysore. Two newly evolved multivoltine silkworm breeds *viz.,* BL67 and 96A were utilized in the present study. Rearing of these breeds were conducted twice during the month of November – December, 2002 and January – February, 2003. Rearing of young age silkworms was carried out at 28 ± 1°C room temperature and 85 ± 5% relative humidity (R. H.). Similarly, the rearing of late age silkworms was carried out at 25 ± 1°C room temperature and 75 ± 5% relative humidity (R. H.). Characteristics of these breeds have been given in Table 1.

After brushing, at least 10 layings were counted in low, medium and high batches in both the breeds. Data were recorded for fecundity, hatching % and % of non-viable eggs. Rearing of low, medium and high batches was carried out. After 3rd moult, 300 larvae were retained and three replications were maintained in each category. Data were recorded for 5th instar larval span, total larval span, yield/10,000 larvae both by number and weight and floss %. On 6th day from the date of spinning, the cocoons were cut with the help of sharp blade. Male and female cocoons were separated by visual observation of the sexual markings located on the ventral side of pupae. Two hundred male and 200 female cocoons were kept separately in cocoon counters for each breed. Single cocoon assessment was carried out using an electronic balance and data were recorded for cocoon weight, cocoon shell weight, pupal weight and cocoon shell ratio. After assessment of cocoons, data were analysed statistically by calculating

Table 1. Characteristics of newly evolved Multivotine Silkworm breeds used in the present study

Breed	Origin	Fecundity	Larval pattern	Larval span (hrs)	Pupation Rate (%)	Cocoon colour & shape	Cocoon weight (g)	Shell weight (cg)	Shell ratio
BL67	CSRTI Mysore	481	Plain	520	94.4	Light greenish yellow Oval	1.33	23.8	17.9
96 A	CSRTI Mysore	475	Plain	540	91.6	Light greenish yellow Oval	1.20	22.2	18.5

Table 2. Average pupal weight (for female) and cocoon shell weight (for male) in newly evolved multivoltine silkworm breeds, BL67 and 96A (Mean ± SD of 200 cocoons) during November – December, 2002

Sl. no.	Breed	Female/ Male	Pupal weight (g)	Cocoon shell weight (cg)
1.	BL67	♀	1.27 ± 0.150	–
		♂	–	22.1 ± 0.033
2.	96A	♀	1.12 ± 0.111	–
		♂	–	21.3 ± 0.023

Table 3. Average pupal weight (for female) and cocoon shell weight (for male) in newly evolved multivoltine silkworm breeds, BL67 and 96A (Mean ± SD of 200 cocoons) during January – February, 2003

Sl. no.	Breed	Female/ Male	Pupal Weight (g)	Cocoon shell weight (cg)
1.	BL67	♀	1.28 ± 0.157	–
		♂	–	21.8 ± 0.036
2.	96A	♀	1.11 ± 0.108	–
		♂	–	21.5 ± 0.027

the Mean Value and Standard Deviation of 200 cocoons for female pupal weight and for male cocoon shell weight (Table 2, 3). Cocoons were categorised into low, medium and high batches based on female pupal weight and male cocoon shell weight (Table 3, 4). After emergence of moths, the female of low, medium and high pupal weight were allowed to mate with males of low, medium and high cocoon shell weight respectively. Further data were recorded for fecundity, hatching %, and % of non-viable eggs and data were analysed statistically.

Table 4. Ranges for selection of females and males in low, medium and high batches in the newly evolved multivoltine silkworm breeds, BL67 and 96A during November – December, 2002

Sl.no.	Breed	Female/ Male	Pupal weight (g)	Cocoon shell weight (cg)
1.	BL67	♀	1.00 – 1.199	–
	(Low)	♂	–	17.0 – 19.9
2.	BL67	♀	1.20 – 1.299	–
	(Medium)	♂	–	20.0 – 21.1
3.	BL67	♀	1.30 – 1.399	–
	(High)	♂	–	22.0 – 25.5
4.	96A	♀	0.80 – 0.999	–
	(Low)	♂	–	16.0 – 19.0
5.	96A	♀	1.00 – 1.099	–
	(Medium)	♂	–	19.1 – 22.0
6.	96A	♀	1.10 – 1.250	–
	(High)	♂	–	22.1 – 25.0

Table 5. Ranges for selection of females and males in low, medium and high batches in the newly evolved multivoltine silkworm breeds, BL67 and 96A during January February, 2003.

Sl. no.	Breed	Female/ Male	Pupal weight (g)	Cocoon shell weight (cg)
1.	BL67	♀	1.00 – 1.200	–
	(Low)	♂	–	14.0 – 20.0
2.	BL67	♀	1.23 – 1.325	–
	(Medium)	♂	–	21.2 – 23.0
3.	BL67	♀	1.35 – 1.450	–
	(High)	♂	–	24.4 – 26.0
4.	96A	♀	0.80 – 1.060	–
	(Low)	♂	–	16.0 – 20.0
5.	96A	♀	1.09 – 1.169	–
	(Medium)	♂	–	21.0 – 22.9
6.	96A	♀	1.19 – 1.255	–
	(High)	♂	–	23.0 – 25.5

Results

Female pupae and male cocoon shells of two multivoltine silkworm breeds were categorised into low, medium and high batch according to their weight and data were recorded for fecundity, hatchability, percentage of unfertilised eggs, 5^{th} age larval span, total larval span, yield/ 10,000 larvae by number and weight, cocoon weight, cocoon shell weight, cocoon shell ratio, floss percentage etc. Data obtained on fecundity, hatchability and percentage of unfertilised eggs in two newly evolved multivoltine silkworm breeds *viz.,* BL67 and 96A reared during November – December, 2002 and January – February, 2003 are presented in table 6 and 8 respectively.

Fecundity, hatchability and percentage of unfertilised eggs: Fecundity

A great deal of variation in fecundity was observed not only between the two multivoltine silkworm breeds in low, medium and high batches but also depending on season. For instance, highest fecundity recorded for BL67 in high batches with high female pupal weight and high male shell weight during November – December, 2002 and January – February, 2003 were 489 and 610 respectively and were found highly significant ($p < 0.01$) when compared to low batches. Fecundity for BL67 in medium batches was 475 and 530 during November – December, 2002 and January – February, 2003 respectively. Statistical analysis showed that the data obtained for fecundity in case of medium batches in BL67 were significant ($p < 0.05$) and highly significant ($p < 0.01$) during November – December, 2002 and January – February, 2003 respectively. When the data were compared between the medium and high batches of BL67, a highly significant ($p < 0.01$) increase in fecundity was noticed in case of high batch during January – February, 2003.

Moreover, data recorded for fecundity in 96A for high batches were 483 and 497, which were highly significant ($p < 0.01$) when compared to low batches during November –December, 2002 and January – February, 2003 respectively. Data obtained for fecundity *i.e.*, 482 in medium batch of 96A during January – February, 2003 showed highly significant ($p < 0.01$) increase in fecundity when compared to low batch. When the data were compared between the medium and high batches of 96A, a highly significant ($p < 0.01$) increase was noticed in case of high batch during November – December, 2002.

Hatchability

Data obtained for hatchability showed a slight change in hatching percentage. In case of BL67, data recorded for hatching percentage in medium batch and low batch showed slightly high percentage of hatching *i.e.*, 96% and 98% during November – December, 2002 and January – February, 2003 respectively. However, there was no significant difference in hatching percentage when compared to low batch. In case of 96A, the high batch during November – December, 2002 and medium batch during January February, 2003 showed a slightly high percentage of hatching *i.e.*, 95% and 97% respectively.

Percentage of unfertilised eggs

During November – December, 2002, no significant change for the percentage of unfertilized eggs was observed. However, a significant reduction ($p < 0.05$) was recorded in high batch of 96A during January – February 2003.

Rearing performance of low, medium and high batches during November – December, 2002

Rearing performance of low, medium and high batches in two multivoltine breeds during November - December, 2002 and January – February, 2003 are presented in Table 5 and 7 respectively.

Fecundity: Differential female pupal weight and male cocoon shell weight of the parent generation significantly influenced the fecundity in the experimental batches of BL67 and 96A. The high batch of BL67 showed a significant ($p < 0.05$) increase in fecundity *i.e.*, 509 and a highly significant ($p < 0.01$) increase in fecundity *i.e.*, 510 was recorded for the high batch of 96A when both the data were compared to their respective low batches. When data were compared between medium and high batches of 96A, a highly significant ($p < 0.01$) increase in fecundity was observed for the high batch.

Total larval span: A significant ($p < 0.05$) reduction in total larval duration was observed for the medium and high batch of 96A as compared to low batch. But no significant difference was observed among different batches of BL67.

Yield/10,000 larvae by weight: A great deal of variation in cocoon yield by weight (kg)/10,000 larvae was recorded due to differential female pupal weight and male cocoon shell weight. The medium batch of BL67 with medium female pupal weight and medium male cocoon shell weight showed a significant ($p < 0.05$) increase in cocoon yield by weight/10,000 larvae *i.e.*, 12.84 kg. A highly significant ($p < 0.01$) increase in cocoon yield by weight/10,000 larvae *i.e.*, 13.52 kg was recorded for the high batch of BL67 with high female pupal weight and high male cocoon shell weight compared to low batch with low female pupal weight and low male cocoon shell weight. But no significant difference was noticed among different batches of 96A.

Cocoon weight: Cocoon weight varied due to the different female pupal weight and male cocoon shell weight. Data obtained for cocoon weight *i.e.*, 1.46 g and 1.55 g revealed a significant ($p < 0.05$) and a highly significant ($p < 0.01$) increase in medium and high batch of BL67 respectively compared to low batch (1.37 g). However, in case of 96A, high batch only showed a significant ($p < 0.05$) increase in cocoon weight *i.e.*, 1.35 g compared to low batch (1.27 g).

Cocoon shell weight: Data recorded for the cocoon shell weight *i.e.*, 26.6 cg and 25.3 cg revealed a significant ($p < 0.05$) increase in high batches of BL67 and 96A corresponding to low batch (for BL67 – 24.8 cg and 96A – 24.3 cg). From the data recorded for cocoon shell weight (Table 7), a trend observed in cocoon shell weight was high batch > medium batch > low batch.

Rearing performance of low, medium and high batches during January – February, 2003

Fecundity: Significant change in fecundity was observed in two multivoltine breeds *viz.,* BL67 and 96A during rearing period of January – February, 2003. The number of eggs laid by the females of medium and high batch of BL67 were significantly high ($p < 0.01$) *i.e.*, 529 and 615 respectively corresponding to low batch *i.e.*, 478. When data were analysed for 96A for fecundity, similar results were observed in medium and high batch which were highly significant ($p < 0.01$) *i.e.*, 482 and 501 respectively corresponding to low batch *i.e.,* 412.

Total larval span: Total larval span did not show significant difference when compared to low batch although the medium batch of BL67 showed a total larval span (468 hrs) compared to high (462 hrs) and low batch (460 hrs). However, total larval span recorded for the medium and low batch of 96A was same *i.e.*, 492 hrs compared to high batch (486 hrs).

Yield/10,000 larvae by weight: Data recorded for cocoon weight by yield/10,000 larvae exhibited a significant and a highly significant increase in both the breeds due to the effect of different female pupal weight coupled with different male cocoon shell weight. The high batch of female pupae coupled with high batch of male cocoon shells showed a highly significant ($p < 0.01$) increase in cocoon weight *i.e.*, 14.22 kg by yield/10,000 larvae compared to low batch (13.22 kg) of BL67, when the medium batch (13.67 kg) of the same breed displayed only a significant ($p < 0.05$) increase compared to the same. Data for different batches of 96A were statistically analysed and compared to low batch for the above parameter and a similar observation was noticed corresponding to BL67.

Cocoon weight: Data obtained for cocoon weight indicated highly significant ($p < 0.01$) increase (Table 9). The medium (1.45 g) and high (1.52 g) batch of BL67 and medium (1.24 g) and high (1.30 g) batch of 96A recorded highly significant increase in cocoon weight corresponding to low batch of BL67 (1.37 g) and 96A (1.18 g) respectively.

Cocoon shell weight: In both the breeds, the results indicated significant differences for cocoon shell weight. The high batch of BL67 displayed highly significant ($p < 0.01$) superiority for cocoon shell weight *i.e.,* 27.2 cg followed by medium batch which yielded a desirable cocoon shell weight of 26.7 cg compared to low batch (24.3 cg). In case of 96A, when comparison was made for the above among the different batches corresponding to low batch, a similar result was noticed where the high batch showed a highly superiority over cocoon shell weight followed by medium and low batch. The trend in cocoon shell weight for both the breeds observed was high > medium > low.

Cocoon shell ratio: In case of BL67, the low and high batch did not show much variation in cocoon shell ratio and it ranged from 17.8 – 17.9% but a highly significant ($p < 0.01$) increase was noticed in medium batch (18.4%) compared low batch (17.9%). In BL67 and 96A, a general tendency observed for cocoon shell ratio was medium > high > low. But in case of 96A, cocoon shell ratio did not reveal significant variation among the different batches compared to low batch and it ranged from 18.6 – 18.8%.

Discussion

The main objective of quality silkworm seed production is to give stabilization and success to the silk industry. Selection of heavy cocoons is a common practice, both for performing breeding and commercial seed production of *Bombyx mori* L. This results in the occurrence of diapause eggs in multivoltine silkworm breeds. In the present study, an attempt has been made to judge the performance of newly evolved multivoltine silkworm breeds by their efficiency for egg production in intrabreed crosses of low × low, medium × medium and high × high batches selected for pupal weight for females and cocoon shell weight for males respectively. Considerable differences in fecundity among the different batches have been noticed. It was observed that the number of eggs laid by a female moth gradually increases with the increase in female pupal weight and male cocoon shell weight.

Maximum numbers of eggs *i.e.*, 610 and 497 in BL67 and 96A were recorded respectively during January – February, 2003 in high batches where the high batch of female pupae and high batch of male cocoon shells according to their weight were allowed to mate. The trend in female fecundity was high batch > medium batch > low batch (Table 6 and 8). The results on increase in fecundity are in conformity with the results of Rahman *et al.*, 1978; Narayanaswamy and Visweswara Gowda, (1989); Govindan *et al.* (1990); Jayaswal *et al.* (1991). Similarly, highly significant correlation between female weight and fecundity has been observed in a bivoltine race of *B. mori* (Shaheen *et al.*, 1992). Ravindra Singh *et al.* (1994a) have also observed that the number of eggs laid by a female increases with the increase in cocoon weight upto a certain extent in a multivoltine strain, Mysore Princess of *B. mori*. Vineet Kumar *et al.* (1998) reported that though other parameters *viz.*, body weight, body length and body width gave the near estimates of the observed fecundity, weight of the female pupa was found as the best estimate in *B. mori*. Similarly, it appears that topical

Table 6. Fecundity, Hatchability and percentage of unfertilised eggs (mean of 10 replications) in newly evolved multivoltine silkworm breeds during November – December, 2002

Breed/ Category	Fecundity	Hatching %	Unfertilized eggs (%)
BL67 (Low)	438	95.3	1.2
BL67 (Medium)	475*	96.0	1.0
BL67 (High)	489**	95.9	0.9
96A (Low)	348	94.3	1.3
96A (Medium)	376	94.5	1.8
96A (High)	483**††	95.2	1.0
F test	**	**	*
CD at 5%	28.42	1.04	0.51
CD at 1%	37.97	1.38	0.68

* and ** denote significantly different at 5% and 1% level respectively.
††denotes significantly different at 1% level when compared to medium.

application of Diethylstilbestrol (DES) at 0.025 µg/ larvae had induced the best increase in the ovary weight and fecundity (Babila Jasmine *et al.*, 2002). However, contradictory result has been reported by Narasimhanna (1988) in the silkworm and he quoted "Feeding silkworms of pure races heavily at final age tend to make pupae heavy and egg laying efficiency of the moth from heavy pupae get reduced".

In the present study, no significant reduction was observed in fecundity but a significant ($p < 0.05$) and a highly significant ($p < 0.01$) increase was noticed in the medium batch of moderately weighing female pupae and in high batch of highly weighing female pupae during November – December, 2002 (Table 6). Interestingly, a highly significant increase was observed in both medium and high batches during January – February, 2003 (Table 8), which supports the findings of Tazima (1958) who reported that the fecundity of silk moths has been found to be affected by the seasons.

Further, highly significant positive correlation between pupal weight and fecundity in some other sericigenous moths has been demonstrated in *Antheraea polyphemus* (Miller *et al.*, 1982), *Antheraea mylitta* (Siddiqui *et al.*, 1989), *Philosomia ricini* (Singh and Prasad, 1987) and *Samia cynthia ricini* (Kotikal *et al.*, 1989).

In the present study, further investigation between female pupal weight and male cocoon shell weight on hatchability was carried out. Though increase female pupal weight and male cocoon shell weight enhances the fecundity, no significant correlation between female pupal

Table 7. Rearing performance of low, medium and high batches (mean of 3 replications) in newly evolved multivoltine silkworm breeds during November – December, 2002

Breed/ Category	Fecundity	Hatching %	5th instar larval span (hrs)	Total larval span (hrs)	Yield/10,000 larvae		Cocoon weight (g)	Cocoon shell weight (cg)	Cocoon shell Ratio	Floss %
					By No.	By Wt. (kg)				
BL67 (Low)	464	98.2	118	460	9,233	12.4	1.37	24.8	18.1	6.9
BL67 (Medium)	489	98.2	126	468	9,066	12.8*	1.46**	25.2	17.3	7.3
BL67 (High)	508*	98.2	120	462	8,444	13.5**	1.55**	26.6*	17.2	7.3
96A (Low)	357	97.0	140	520	9,066	11.4	1.27	24.3	19.1	7.3
96A (Medium)	393	97.5	126	486*	9,089	11.5	1.32	24.9	18.9	7.9
96A (High)	510**	97.6	120	480*	8,978	11.7	1.35*	25.3*	18.8	8.0
CD at 5%	41	1.05	12.3	30.3	–	0.340	0.07	0.01	0.64	–
CD at 1%	58	1.51	17.5	43.1	–	0.480	0.09	0.02	0.90	–
CV %	5.00	0.60	5.40	3.50	2.20	1.50	2.30	2.80	1.90	9.00

* and ** denote significantly different at 5% and 1% level respectively.

Table 8. Fecundity, hatchability and percentage of unfertilised eggs (mean of 10 replications) in newly evolved multivoltine silkworm breeds during January – February, 2003

Breed/ Category	Fecundity	Hatching %	Unfertilized eggs (%)
BL67 (Low)	479	98.1	0.4
BL67 (Medium)	530**	98.0	0.4
BL67 (High)	610**††	97.7	0.5
96A (Low)	412	97.4	0.5
96A (Medium)	482**	97.7	0.6
96A (High)	497**	97.7	0.4*
F test	**	–	–
CD at 5%	31.4	0.61	0.16
CD at 1%	42.0	0.82	0.21

* and ** denote significantly different at 5% and 1% level respectively

– denotes non-significant.

†† denotes significantly different at 1% level when compared to medium.

weight and male cocoon shell weight on hatchability percentage was noticed in parent and succeeding generation when comparison was made with low batches. Significant gradual increase in hatching percentage was reported by Narayanaswamy and Visweswara Gowda (1989) in *B. mori* in combinations of low × low (62.5%), medium × medium (76.0%) and high × high (80.8%) where the low, medium and high weighing female pupae according to their weight were combined with their respective males, but the results were in conformity only in respect when no significant variation was observed in succeeding generation due to differential pupal weight combinations used in parent generation. The present results are in agreement with Govindan *et al.* (1990) where no significant difference for hatching percentage was observed due to different pupal graded in parent as well as succeeding generation.

A significant ($p < 0.05$) decrease in the percentage of unfertilized eggs was noticed in case of high batch of 96A only during January – February, 2003 (Table 8). The results indicated that the season influenced the reduction of unfertilized eggs in proportion to the female pupal weight and male cocoon shell weight. Similar results were observed up to a certain extent in the moths of *B. mori*, categorised according to female cocoon weight (Ravindra Singh *et al.*, 1994a).

Table 9. Rearing performance of low, medium and high batches (mean of 3 replications) in newly evolved multivoltine silkworm breeds during January – February, 2003

Breed/ Category	Fecundity	Hatch-ing %	5th instar larval span (hrs)	Total larval span (hrs)	Yield/10,000 larvae By No.	Yield/10,000 larvae By Wt. (kg)	Cocoon weight (g)	Cocoon shell weight (cg)	Cocoon shell Ratio	Floss %
BL67 (Low)	478	98.2	114	480	9,600	13.20	1.37	24.3	17.8	6.5
BL67 (Medium)	529**	98.2	116	482	9,400	13.67*	1.45**	26.7**	18.4**	6.5
BL67 (High)	615**	98.2	114	480	9,383	14.22**	1.52**	27.2**	17.9	6.3
96A (Low)	412	97.0	126	492	9,700	11.23	1.18	22.0	18.6	5.6
96A (Medium)	482**	97.5	126	492	9,569	11.75*	1.24**	23.3**	18.8	5.6
96A (High)	501**	97.6	120	486	9,667	12.58**	1.30**	24.2**	18.6	5.5
CD at 5%	13	1.05	11.73	10.71	–	0.41	0.026	0.008	0.33	0.36
CD at 1%	18	1.51	16.68	15.23	–	0.59	0.038	0.011	0.48	0.51
CV %	1.40	0.60	5.40	1.00	1.60	1.80	1.10	1.70	0.33	3.30

* and ** denote significantly different at 5% and 1% level respectively.

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